



U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration



MAOP Verification for Natural Gas Pipelines



PHMSA's goal is to improve the overall integrity of pipeline systems and reduce risks.



I follow the rules because I have to!

I follow the rules because I want to!



San Bruno, California

September 9, 2010

- 30 inch steel pipeline explosion
- Killed 8 and injured many more
- Destroyed 38 homes and damaged 70 more
- 47.6 million standard cubic feet of gas released



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San Bruno





San Bruno





San Bruno





Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the Pacific Gas and Electric Company's (PG&E) (1) inadequate quality assurance and quality control in **1956** during its Line 132 relocation project, which allowed the installation of a substandard and poorly welded pipe section with a visible seam weld flaw that, over time grew to a critical size, causing the pipeline to rupture during a pressure increase stemming from poorly planned electrical work at the Milpitas Terminal; and (2) inadequate pipeline integrity management program, which failed to detect and repair or remove the defective pipe section.



- Record showed the pipe to be seamless API 5L X42 pipe.
- The pipe segment that ruptured was longitudinal welded pipe consisting of 5 sections with some as short as 4 feet.
- There were different longitudinal weld types including single and double sided welds



April 2011, AGA White Paper on Verification of MAOPs for Existing Steel Transmission Pipelines

- **Attachment B**
- **Released by PHMSA April 22, 1998**
- **DETERMINATION OF MAXIMUM ALLOWABLE
OPERATING PRESSURE IN NATURAL GAS PIPELINES**



Part 192.619(a)(3): Historic Operating Pressure.

For onshore pipelines, review records for the highest operating pressure between July 1, 1965, and July 1, 1970, such as pressure charts, regulator station inspection reports showing inlet or outlet pressures, etc. (If no records are available, a notarized statement by a person in charge of pipeline operations during that time period, attesting to the operating pressure during that period, **may** be acceptable at the discretion of regulatory agencies).



ADB-11-01

- **In** recent pipeline accident investigations, NTSB and PHMSA have discovered indications that operator oversight of IM programs has been lacking and thereby failed to detect flaws and deficiencies in their programs.
- The level of self-evaluation and oversight currently being exercised by some pipeline operators is not uniformly applied.



ADB-11-01

The NTSB is also concerned that pipeline operators throughout the United States may have discrepancies in their records that could potentially compromise the safe operation of their pipelines..



ADB-11-01

To further enhance the Department's safety efforts and implement the NTSB's January 3, 2011, PHMSA is issuing this Advisory Bulletin concerning establishing MAOP and MOP using record evidence and integrity management; threat and risk identification; risk assessment; risk information collection, accuracy and integration, and identification and implementation of preventive and mitigative measures.



ADB-11-01

- As PHMSA and NTSB recommended, operators relying on the review of design, construction, inspection, testing and other related data to calculate MAOP or MOP must assure that the records used are reliable.
- These records shall be **traceable, verifiable, and complete**.
- If such a document and records search, review, and verification cannot be satisfactorily completed, the operator cannot rely on this method for calculating MAOP or MOP.



ADB-12-06

PHMSA is issuing an Advisory Bulletin to remind operators of gas and hazardous liquid pipeline facilities to verify their records relating to operating specifications for maximum allowable operating pressure (MAOP) required by 49 CFR 192.517 and maximum operating pressure (MOP) required by 49 CFR 195.310.



ADB-12-06

- Owners and operators should consider the guidance in this advisory for all pipeline segments and take action as appropriate to assure that all MAOP and MOP are supported by records that are traceable, verifiable and complete.
- Traceable records might include pipe mill records, purchase requisition, or as-built documentation indicating minimum pipe yield strength, seam type, wall thickness and diameter.



ADB-12-06

- Verifiable records are those in which information is confirmed by other complementary, but separate, documentation.
- In general, the only acceptable use of an affidavit would be as a complementary document



According to the Innocence Project 73% of the 239 convictions overturned through DNA testing were based on eyewitness testimony!



ADB-12-06

If such a document and records search, review, and verification cannot be satisfactorily completed, the operator cannot rely on this method for calculating MAOP or MOP and must instead rely on another method as allowed in 49 CFR 192.619 or 49 CFR 195.406.



MAOP

"Maximum Allowable Operating Pressure"
means the maximum pressure at which a
pipeline or segment of a pipeline may be
operated under this part.

§192.3



MOP

"Maximum Actual Operating Pressure"
means the maximum pressure that occurs
during normal operations over a period
of one year.

§192.3



Class Location Definition

§192.5

The *class location unit* is an onshore area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline.

The class location is determined by the buildings in the *class location unit*. For the purposes of this section, each separate dwelling unit in a multiple dwelling building is counted as a separate building intended for human occupancy.



Class Location Unit

- A ***Class 1*** = 10 or less buildings intended for human occupancy or an offshore area.
- A ***Class 2*** = Greater than 10 but less than 46 buildings intended for human occupancy.
- A ***Class 3*** = 46 or more buildings intended for human occupancy; or



Class Location Unit

Class 3 - where the pipeline lies within 100 yards of either a building or a small,

➤ **Well-defined Outside Area**

- **Playground**
- **Recreation Area**
- **Outdoor Theater**

➤ **Occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12-month period**





Class Location Unit

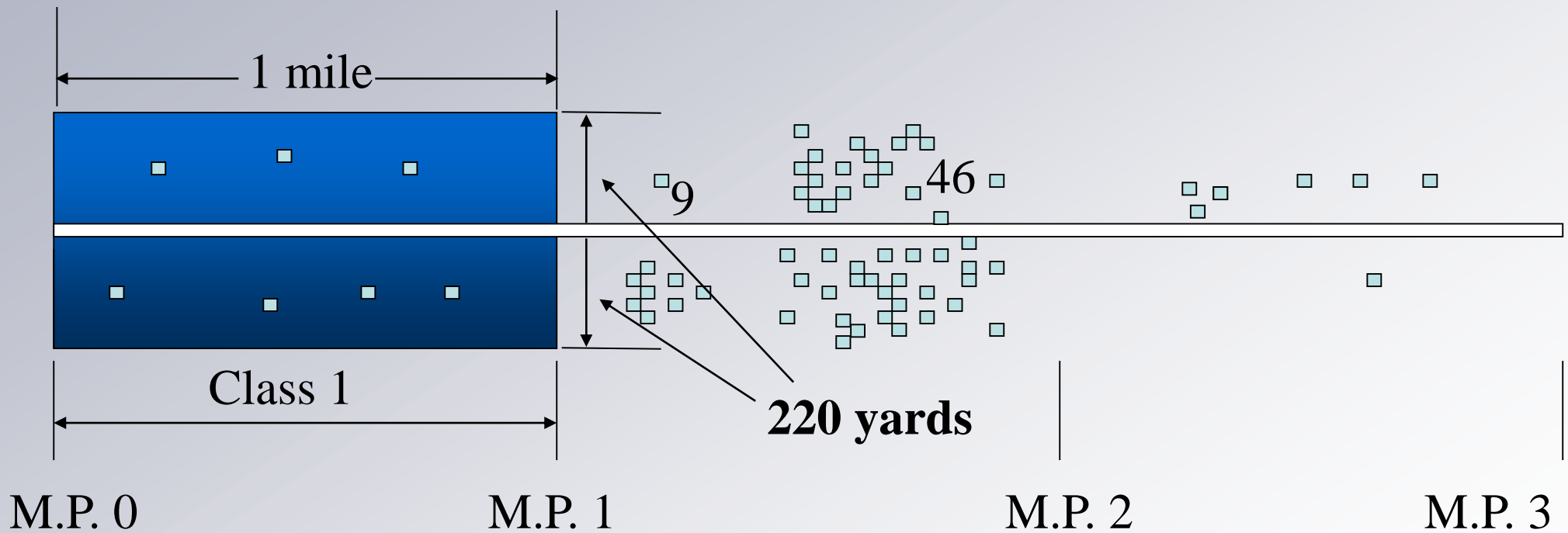
Class 4 - where buildings with four or more stories aboveground are prevalent.

“Prevalent” means
“widely existing”





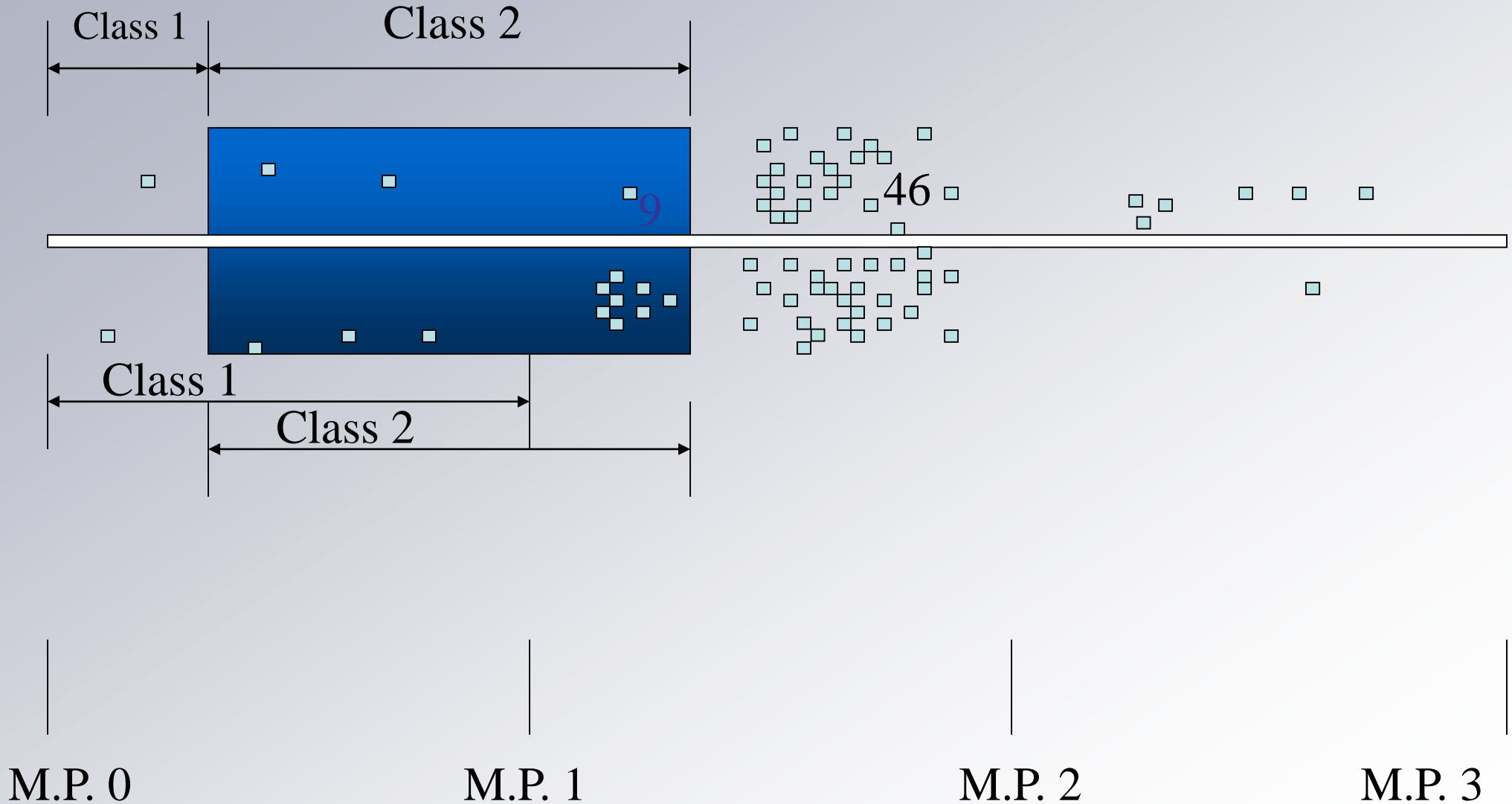
Class Location Determination



M.P. = Mile Post

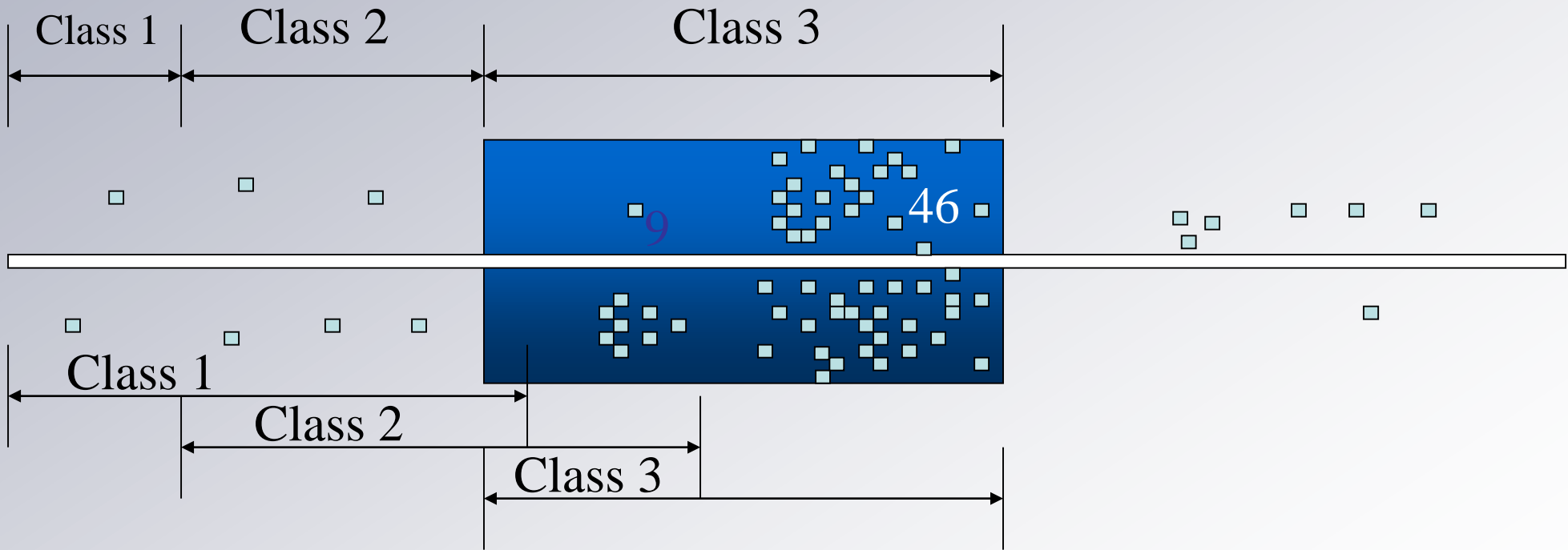


Continuous Sliding Mile



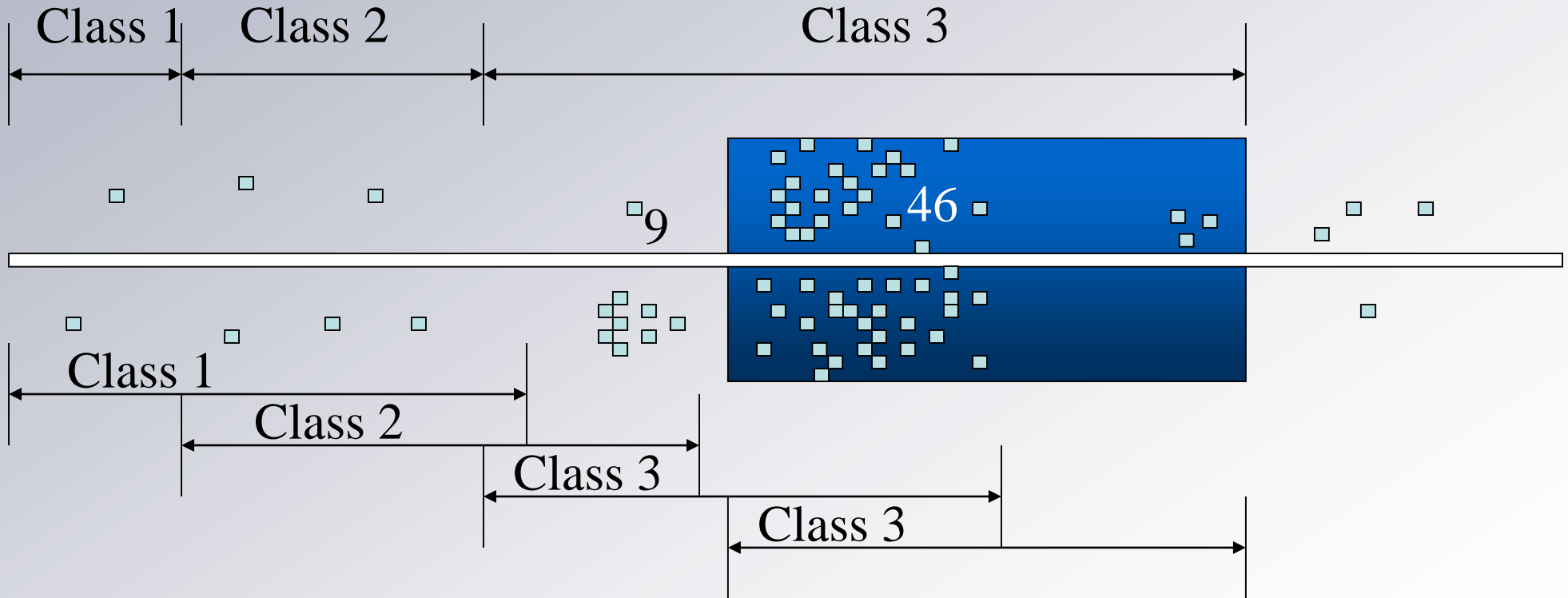


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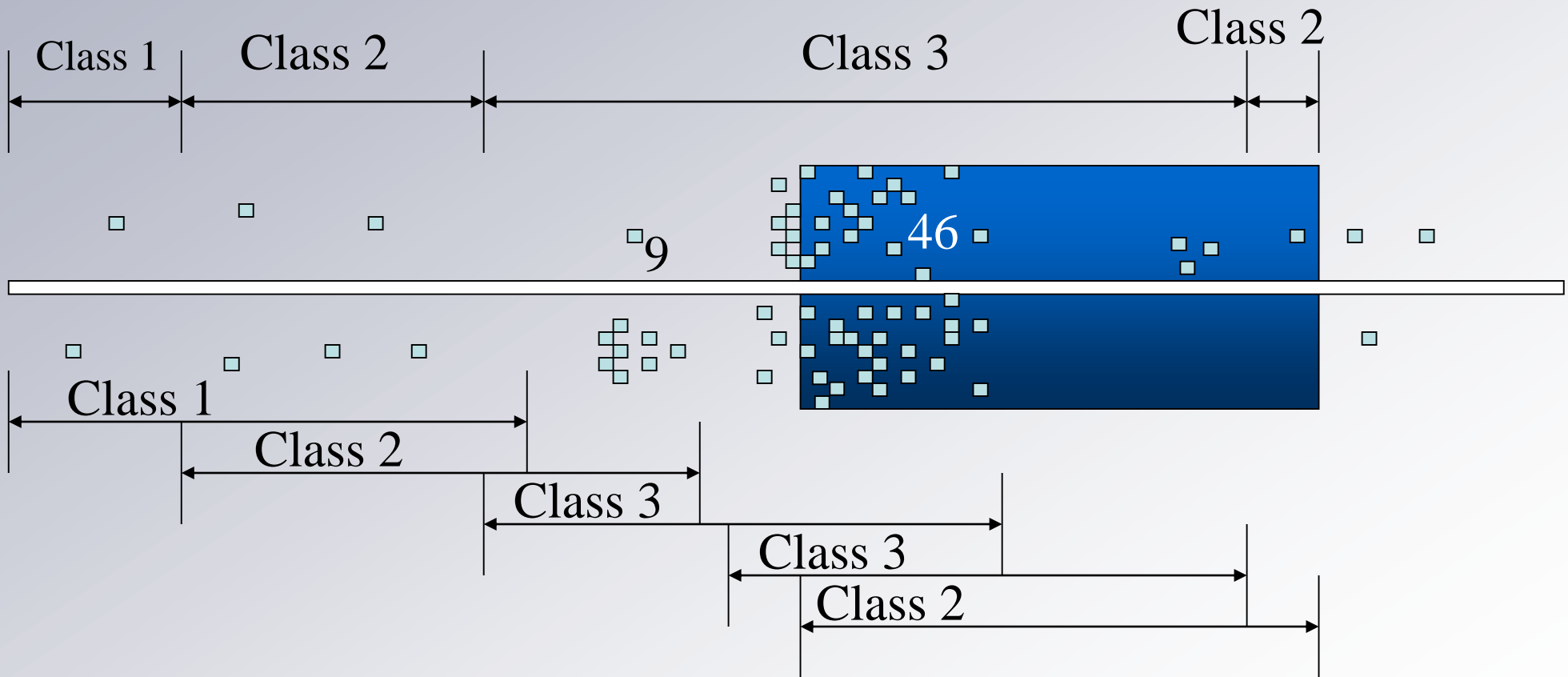


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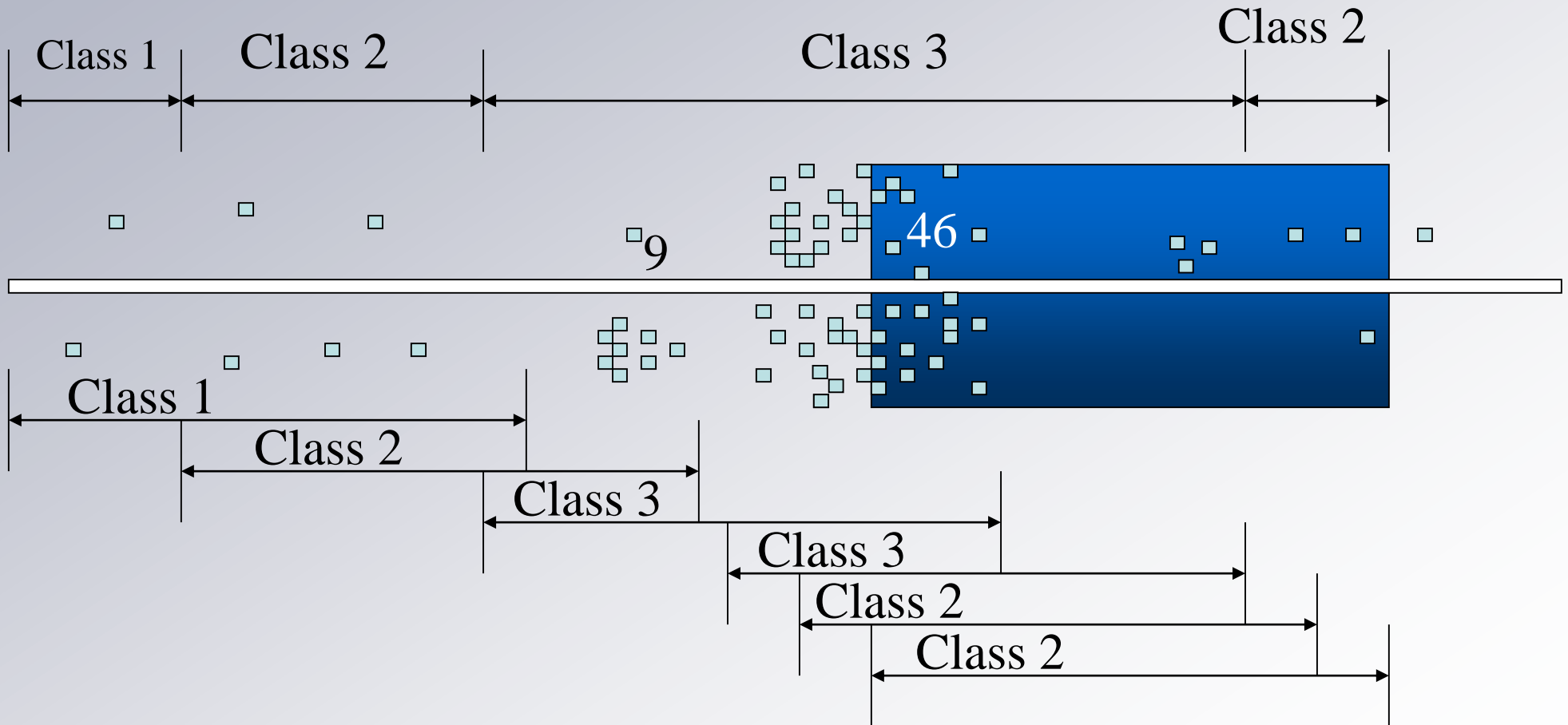


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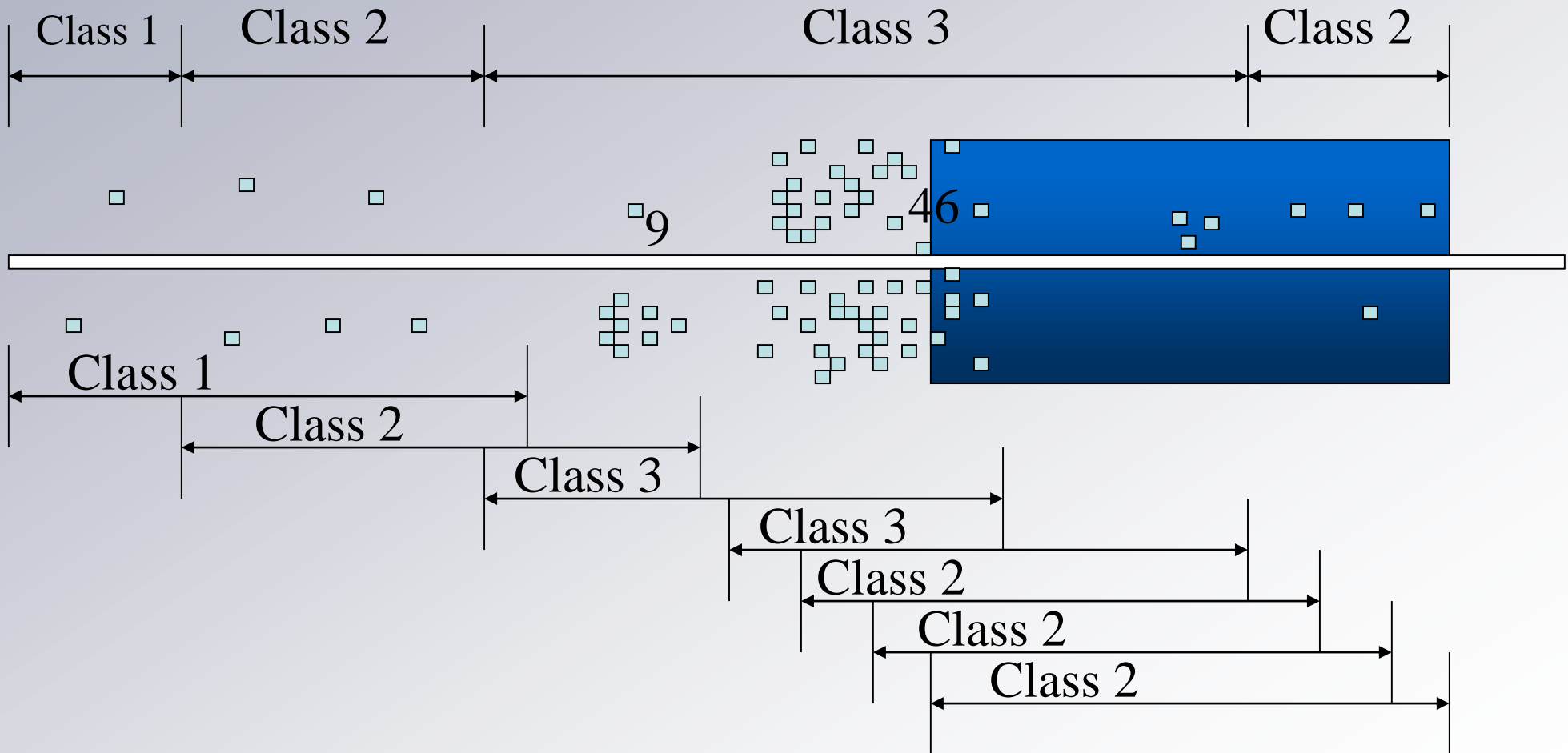


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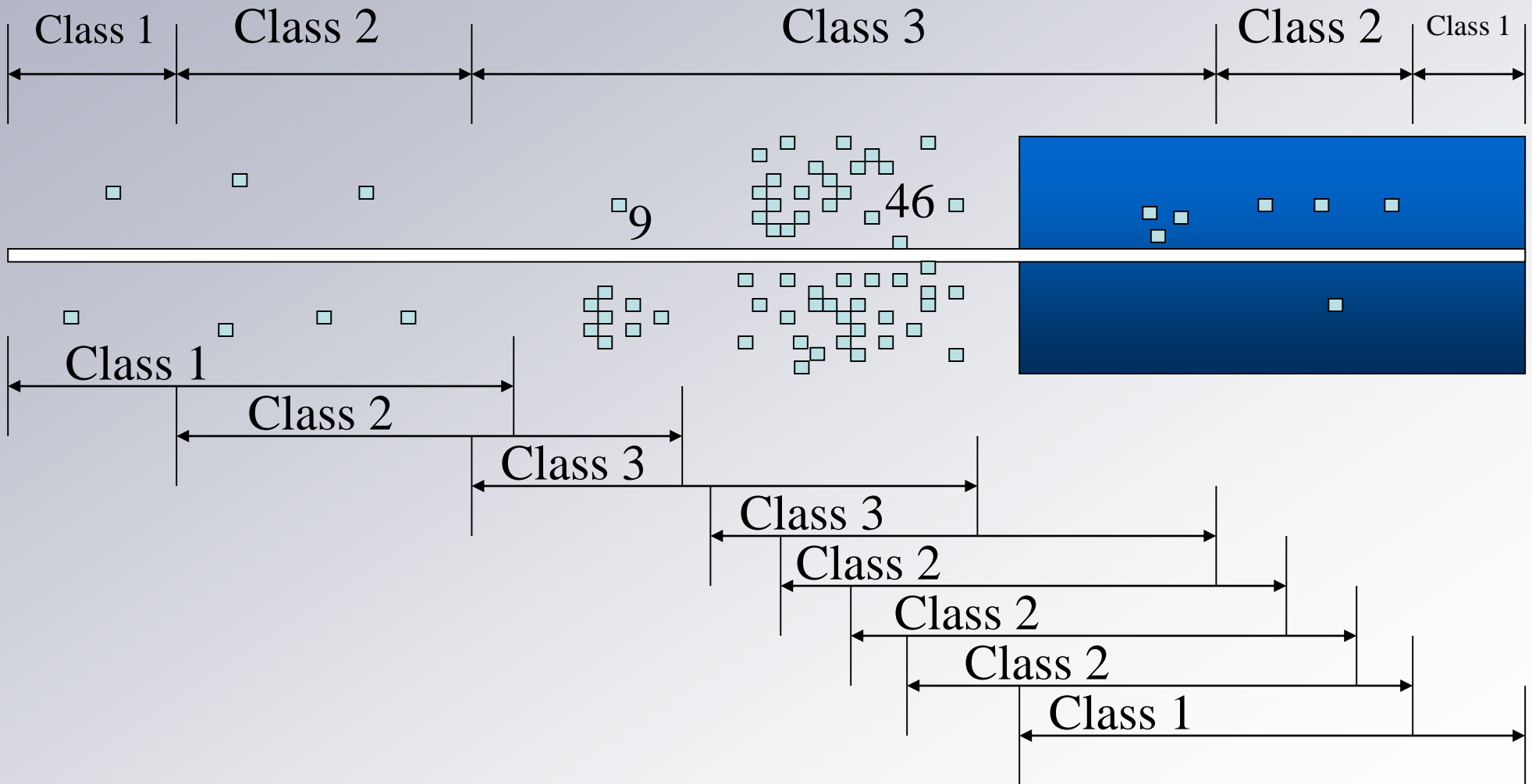


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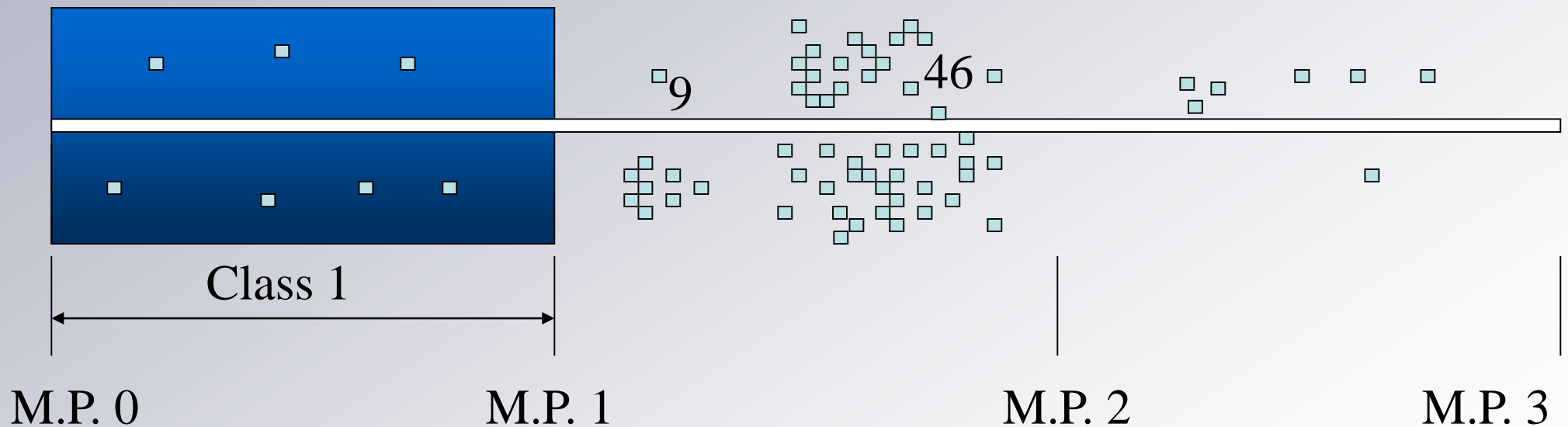


Continuous Sliding Mile



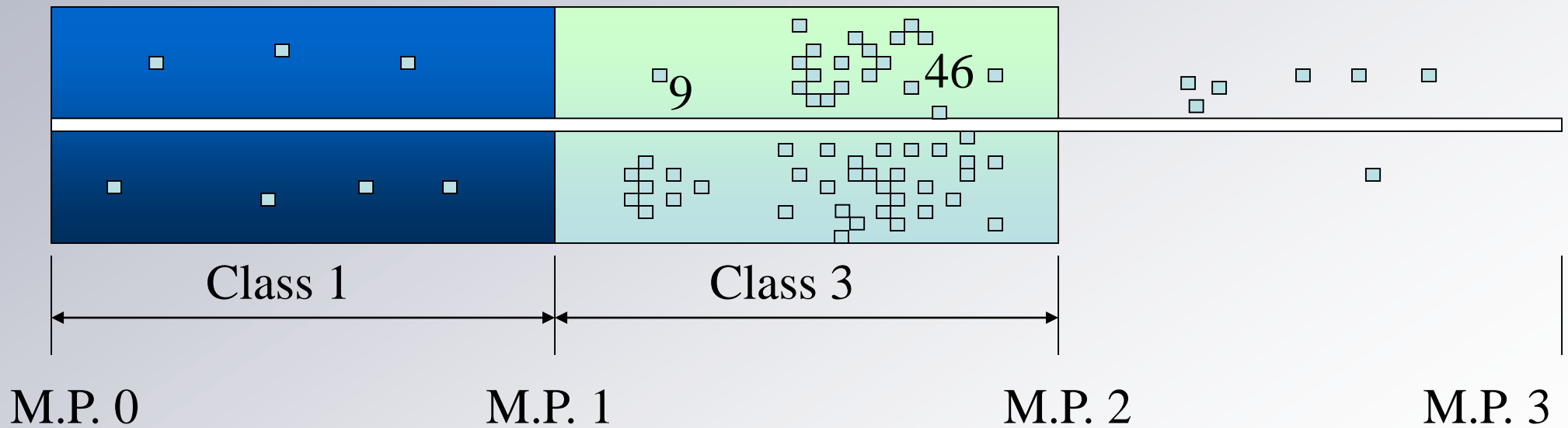


Improper Class Location Determination



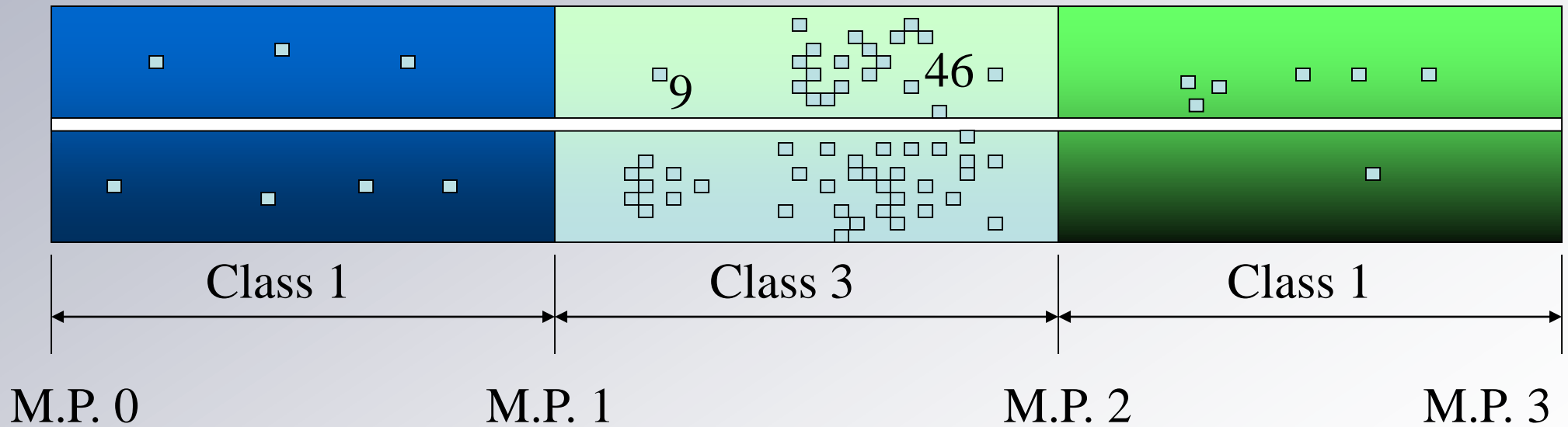


Improper Class Location Determination



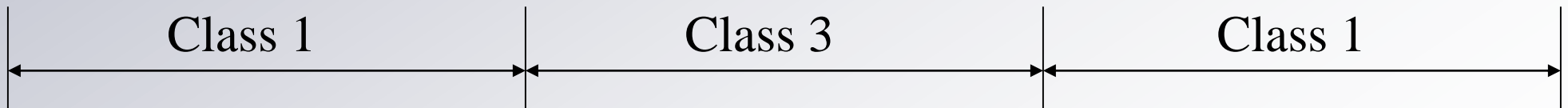
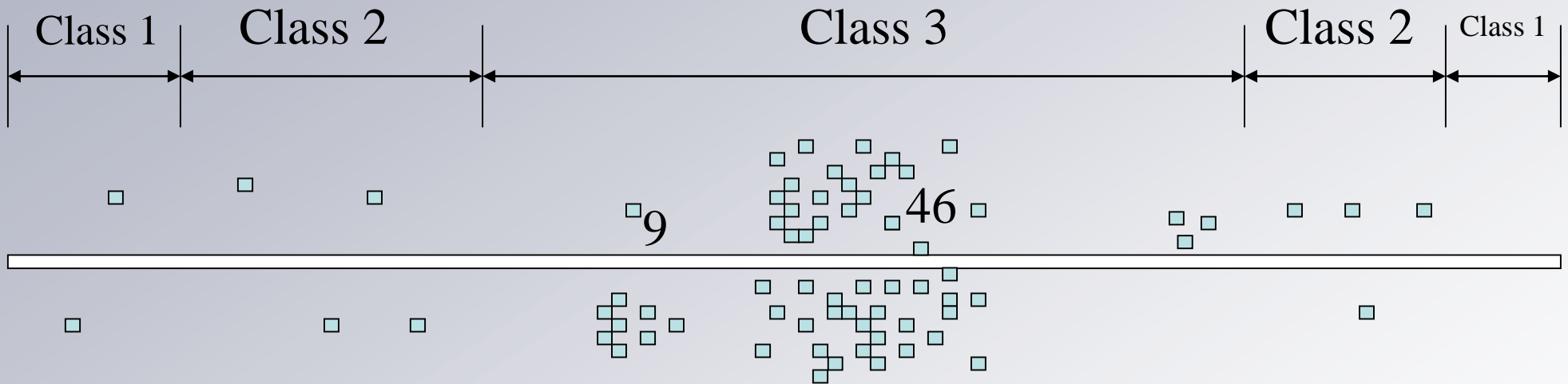


Improper Class Location Determination





Continuous Sliding Mile

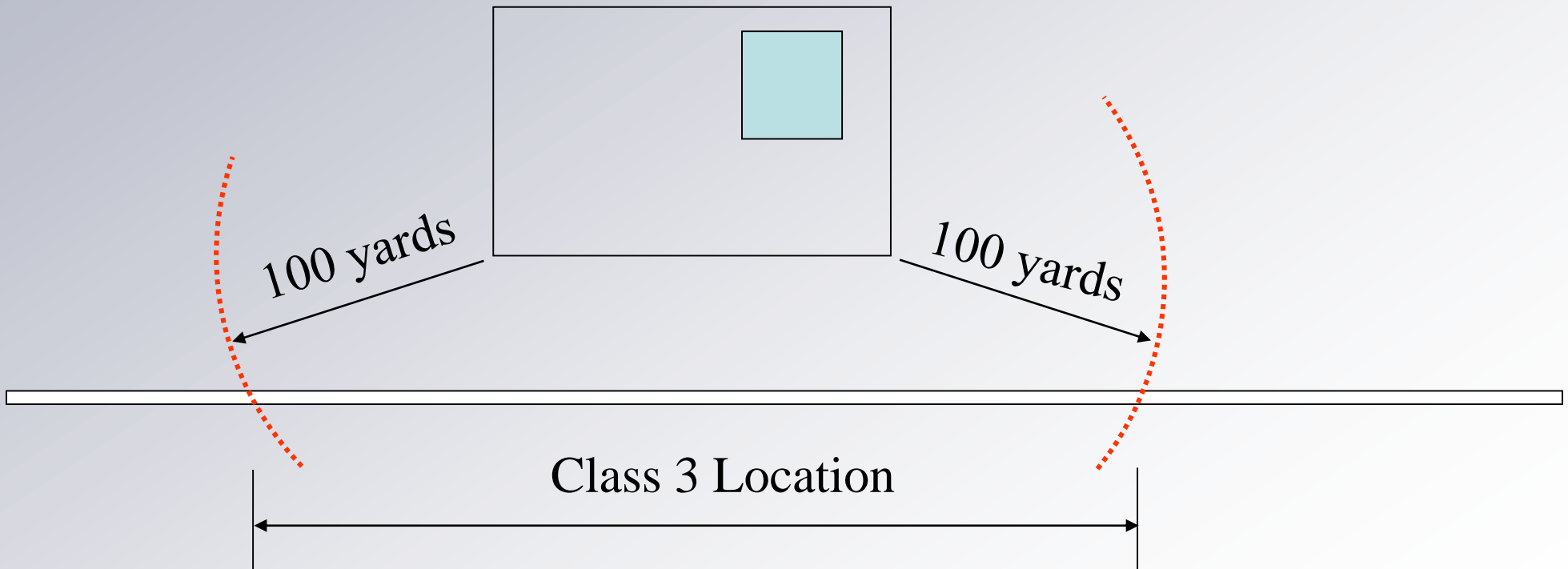


End-to-End Mile



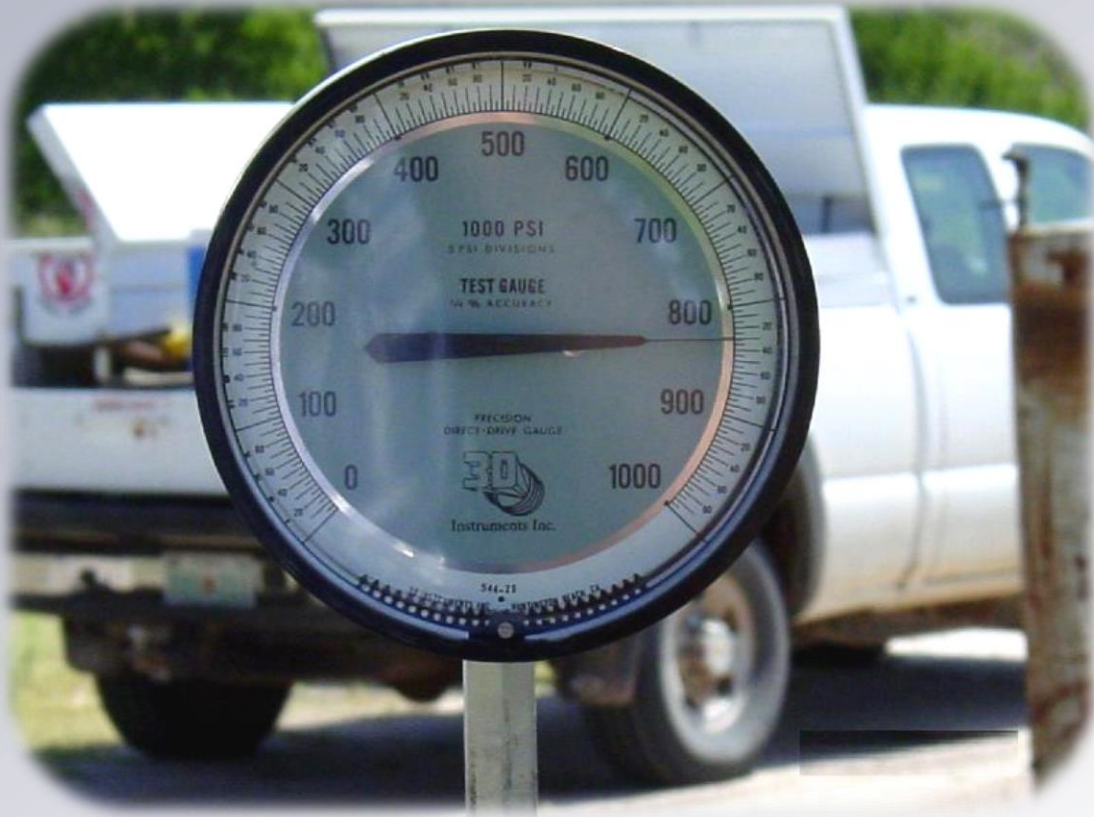
Class 3 – Small Well Defined Area

School with Playground





MAOP Found In Sub Parts



✓ 192.619

✓ 192.621

✓ 192.623



§192.619 - All Pipelines

Lowest of the following:

- (a)(1) Design
- (a)(2) Test Pressure
- (a)(3) MOP during the 5 years preceding the applicable date in (a)(3)
- (a)(4) Maximum Safe Pressure determined by the Operator
(For de-rating only)



§192.619 - All Pipelines

Lowest of the following:

(a)(1) Design



(a)(2) Test Pressure

(a)(3) MOP during the 5 years preceding the applicable date in (a)(3)

(a)(4) Maximum Safe Pressure determined by the Operator
(For de-rating only)



Design of Pipe and Components

Pipe

- For Steel - §192.105
- For Plastic - §192.121

Components

- Manufacturers Rating





§192.105 - Design of Steel Pipe

$$P = (2St/D)(F)(E)(T)$$

P = Design Pressure

S = Yield Strength

D = Outside Diameter

t = Wall Thickness

F = Design factor - §192.111

E = Longitudinal joint factor - §192.113

T = Temperature de-rating factor - §192.115



Pipe Specifications

API 5L
Grade B
8"
.322" wt.





Design Pressure Calculation

$$P = 2St / D$$

$$P = (2)(35,000)(.322) / 8.625$$

$$P = 2613\#$$

Equivalent Pressure
at 100% SMYS





§192.111 - Design Factor (F) for Steel Pipe

$$P = \frac{2St}{D} (F)$$

Class location	Design factor (F)
1	.72
2	.60
3	.50
4	.40



§192.111 - Design Factor (F) for Steel Pipe In Class 3

$$P = \frac{(2)(35,000)(.322)(0.50)}{8.625}$$

$$P = 1307\#$$



E = Longitudinal Joint Factor - §192.113

T = Temperature De-rating Factor - §192.115

**Usually Not a Factor
Be Sure to Check!!**

(250°F or less)





Components



- **1000# WOG Valve**
- **ANSI Class 300# Flange**
- **ANSI Class 600# Valve**

(WOG = Water, Oil, Gas)



Components Pressure Ratings

- 1000# WOG Valve - 1000#
- ANSI Class 300# Flange - 720# / 740#
(After 03/04/1981)
- ANSI Class 600# Valve - 1440#

Manufacturer's Rating





Design Pressure of the Weakest Link

Components = 720# / 740#
(After 03/04/1981)
Pipe = 1307#



§192.619 - All Pipelines

Lowest of the following:

(a)(1) Design = 720#

(a)(2) Test Pressure ←

(a)(3) MOP during the 5 years preceding the applicable date in (a)(3)

(a)(4) Maximum Safe Pressure determined by the Operator (For de-rating only)



§192.619 (a)(2)(ii)

Test Pressure / Factor

**Testing Steel
≥ 100# PSIG**

Class location	Installed before (Nov. 12, 1970)	Installed after (Nov. 11, 1970)	Covered under §192.14
1	1.1	1.1	1.25
2	1.25	1.25	1.25
3	1.4	1.5	1.5
4	1.4	1.5	1.5



Test Pressure / Factor

Test Pressure - 1964 = 1500#

For Class 3 - 1500/1.4 = 1071#





§192.619 - All Pipelines

Lowest of the following:

(a)(1) Design = 720#

(a)(2) Test Pressure = 1071#

(a)(3) MOP during the 5 years preceding the applicable date in (a)(3) ←

(a)(4) Maximum Safe Pressure determined by the Operator
(For de-rating only)



MOP – Transmission and Distribution Lines

- 5 years preceding the applicable date in §192.619 (a)(3)

Unless:

- Tested in accordance §192.619(a)(2) after July 1, 1965
- Upgraded in accordance with Subpart K of this part.



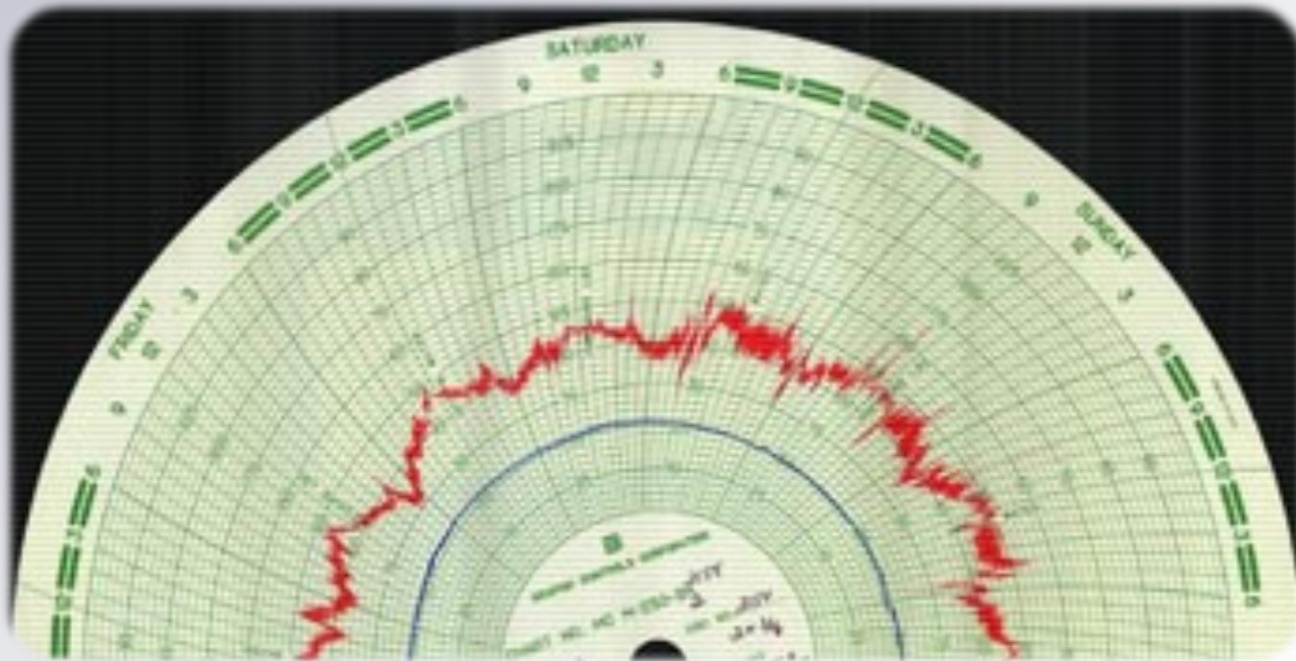
192.619 (a)(3)

Pipeline segment	Pressure date	Test date
<ul style="list-style-type: none">—Onshore gathering line that first became subject to this part (other than §192.612) after April 13, 2006.—Onshore transmission line that was a gathering line not subject to this part before March 15, 2006.	March 15, 2006, or date line becomes subject to this part, whichever is later.	5 years preceding applicable date in second column.
Offshore gathering lines.	July 1, 1976.	July 1, 1971.
All other pipelines.	July 1, 1970.	July 1, 1965.



MOP

Operating Charts for 1968 - 850#





§192.619 - All Pipelines

Lowest of the following:

(a)(1) Design = 720# / **740# (After 03/04/1981)**

(a)(2) Test Pressure = 1071#

(a)(3) MOP = 850#

(a)(4) Maximum Safe Pressure determined by the
Operator **(For de-rating only)** ←



Maximum Safe Pressure

Considering:



- History
- Corrosion
- Actual Operating Pressure

(For de-rating only)



§192.619(b)

Maximum Safe Pressure

If used:

Must provide Overpressure Protection as required by §192.195





§192.619(c) *Grandfather Clause*

The requirements on pressure restrictions in this section **do not apply** in the following instance.

An operator may operate a segment of pipeline found to be in satisfactory condition, considering it's operating and maintenance history, at the **highest actual operating pressure** to which the segment was subjected **during the 5 years preceding the applicable date** in the second column of the table in paragraph (a)(3) of this section.



§192.619(c)

Design = 720#

Test Pressure = 1500#

MOP = 850#



§192.619 - All Pipelines

Plastic Pipeline

Lowest of the following:

- (a)(1) Design**
- (a)(2) Test Pressure**
- (a)(3) MOP during the 5 years preceding the applicable date**
- (a)(4) Maximum Safe Pressure determined by the Operator (For de-rating only)**



§192.619 - All Pipelines

Plastic Pipeline

Lowest of the following:

(a)(1) Design



(a)(2) Test Pressure

(a)(3) MOP during the 5 years preceding the applicable date in (a)(3)

(a)(4) Maximum Safe Pressure determined by the Operator (For de-rating only)



Design of Pipe and Components

Pipe

- For Steel - §192.105
- For Plastic - §192.121

Components

- Manufacturers Rating





§192.121 - Design of Plastic Pipe

$$P = \frac{2S \times 0.32}{(SDR - 1)}$$

- **P = Design Pressure**
- **S = Long Term Hydrostatic Strength - estimated tensile hoop stress that when applied continuously failure of the pipe at 100,000 hours (11.43 years) - *(HDB - Hydrostatic Design Base)***
- **SDR = Standard Dimension Ratio = outside diameter /wall thickness**



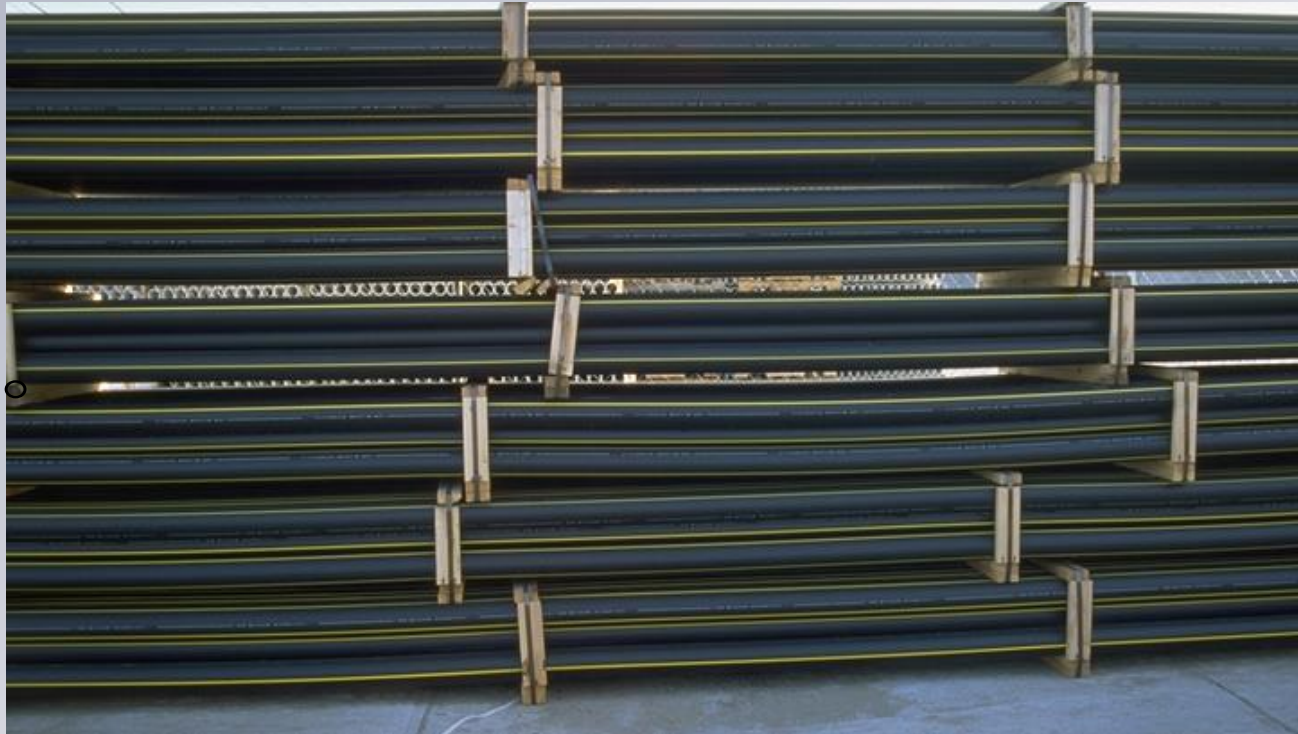
Hydrostatic Design Base

Thermoplastic Pipe

Piping Material	73° F	100° F	120° F	140° F
2606/2780	1250	1250	1000	800
3608/3710 4608/4710	1600	1250	1000	800



Pipe Specifications



**PE 4710
ASTM - D2513
4" Diameter,
SDR = 11
Ambient Temp. 84° F**



§192.121 - Design Pressure

$$P = 2S / (SDR - 1) \times 0.32$$

$$P = \frac{(2)(1250)}{(11 - 1)} \times 0.32 = 80\#$$





$$P = 2S / (SDR - 1) \times 0.32$$

73 °F

$$P = (2)(1600) / (11-1) \times 0.32 = 102\#$$

100 °F

$$P = (2)(1250) / (11-1) \times 0.32 = 80\#$$

120 °F

$$P = (2)(1000) / (11-1) \times 0.32 = 64\#$$

140 °F

$$P = (2)(800) / (11-1) \times 0.32 = 51\#$$





Design Pressure

Plastic Pipe

Piping Material	73 °F	100 °F	120 °F	140 °F
2606/2780	80	80	64	51
3608/4710	102	80	64	51

SDR = 11

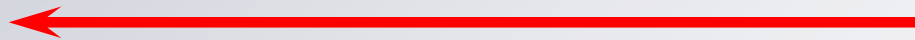


§192.619 - All Pipelines ***Plastic Pipeline***

Lowest of the following:

(a)(1) Design = 80#

(a)(2) Test Pressure



(a)(3) MOP during the 5 years preceding the applicable date

(a)(4) Maximum Safe Pressure determined by the Operator (For de-rating only)



§192.619 - All Pipelines

Plastic Pipeline

For Plastic - Test Pressure / 1.5

Test Pressure - 1964 = 95#

$95 / 1.5 = 63\#$





§192.619 - All Pipelines

Plastic Pipeline

Lowest of the following:

(a)(1) Design = 80#

(a)(2) Test Pressure = 63#

(a)(3) MOP during the 5 years preceding the applicable
date ←

(a)(4) Maximum Safe Pressure determined by the Operator
(For de-rating only)



MOP

- Highest actual operating history for the 5 years preceding the applicable date in §192.619 (a)(3)

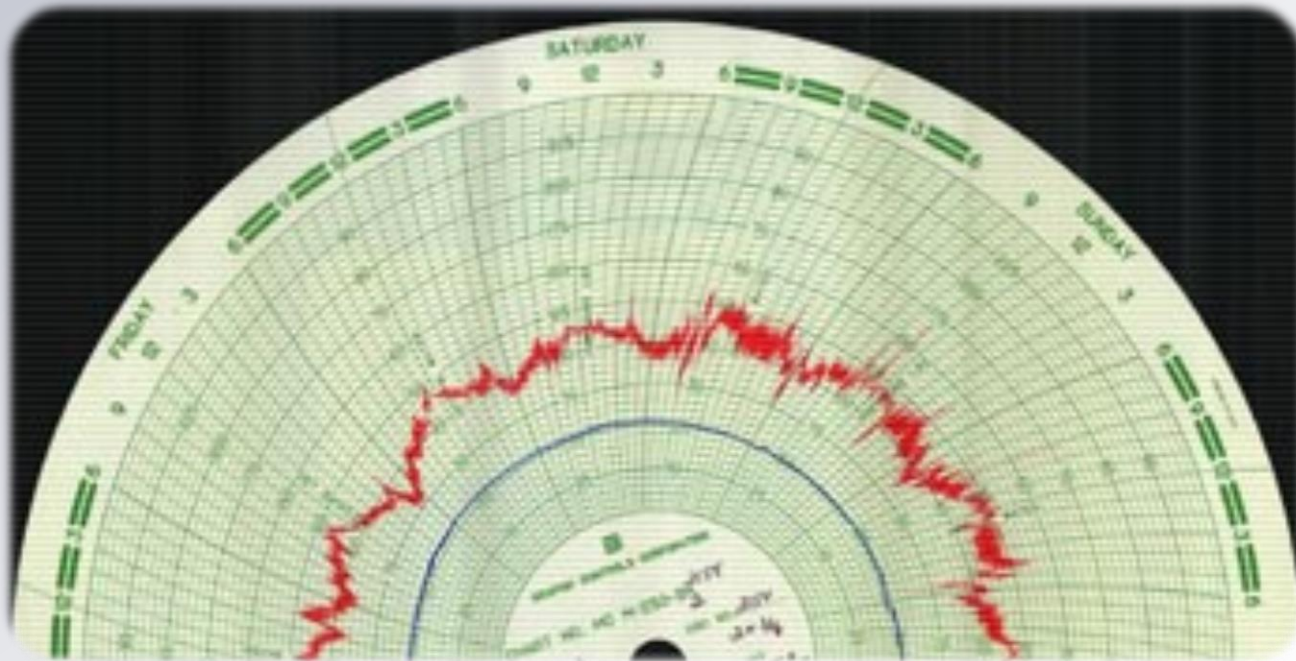
Unless:

- Tested in accordance §192.619(a)(2) after July 1, 1965
- Up-rated in accordance with Subpart K of this part.



MOP

Operating Charts for 1968 - 45#





§192.619 - All Pipelines *Plastic Pipeline*

Lowest of the following:

(a)(1) Design = 80#

(a)(2) Test Pressure = 63#

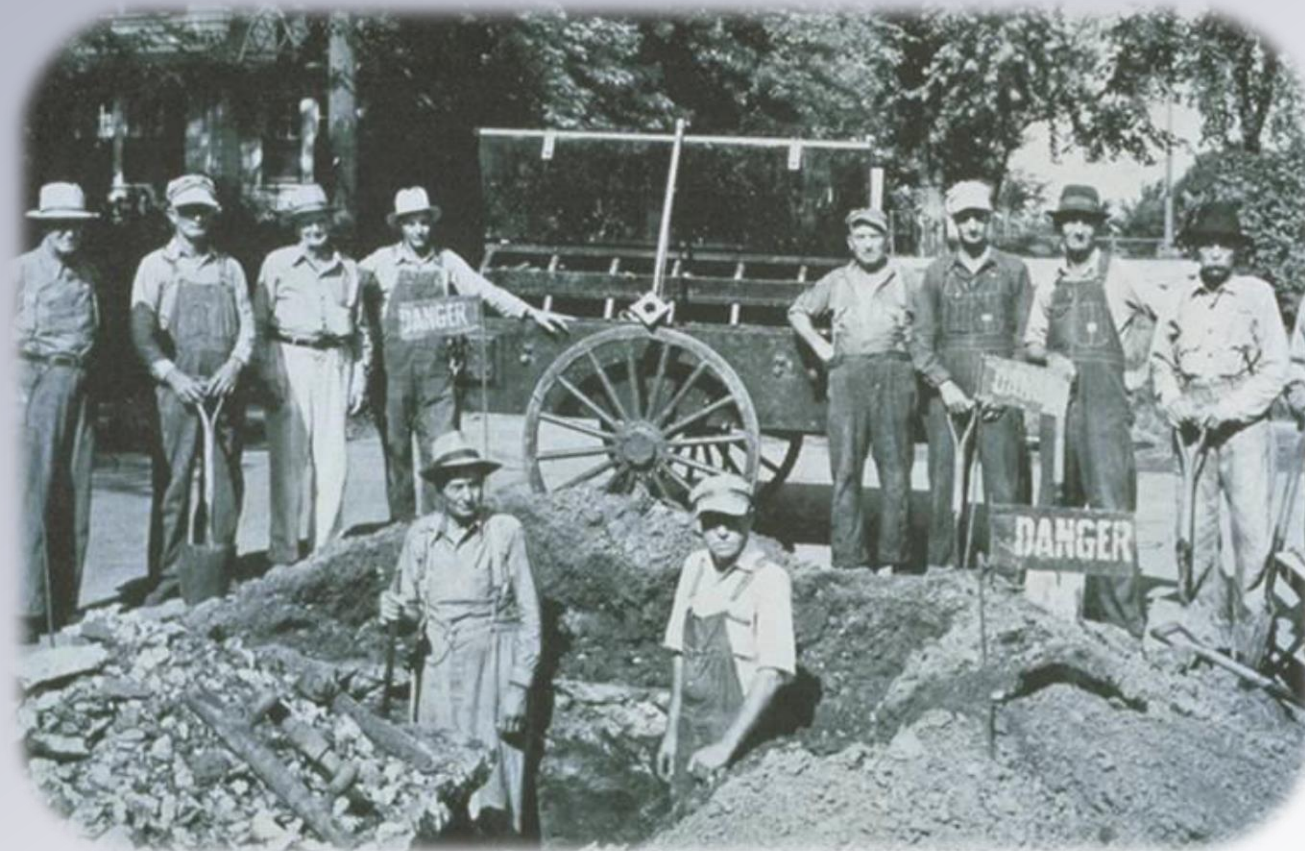
(a)(3) MOP = 45#

(a)(4) Maximum Safe Pressure determined by the ←
Operator (For de-rating only)



Maximum Safe Pressure

Considering:



- History
- Corrosion
- Actual Operating Pressure

(For de-rating only)



For Distribution

From §192.619 carry over determined MAOP

Does §192.619(c) apply?

- **High Pressure Distribution - §192.621**
- **Low Pressure Distribution - §192.623**



High Pressure Distribution System



Means a distribution system in which the gas pressure in the main is higher than the pressure provided to the customer.

(Service Regulators)



§192.621 MAOP: High-Pressure Distribution Systems.

Lowest of the following:

(a)(1) Design

(a)(2) 60# - unless service lines equipped with pressure limiting devices meeting §192.197(c)



§192.621 MAOP: High-Pressure Distribution Systems.

Lowest of the following:

(a)(1) *Design* ←

(a)(2) **60#** - unless service lines equipped with pressure limiting devices meeting §192.197(c)



§192.621 MAOP: High-Pressure Distribution Systems.

Lowest of the following:

(a)(1) Design = 80#

(a)(2) 60# - unless service lines equipped with pressure limiting devices meeting §192.197(c) ←





§192.621 MAOP: High-Pressure Distribution Systems.

Lowest of the following:

(a)(1) Design = 80#

(a)(2) 60# - unless service lines equipped with pressure limiting devices meeting §192.197(c)

§192.619(a)(3) 45# ←

((a)(3) MOP during the 5 years preceding the applicable date)



Low Pressure Distribution System

Means a distribution system in which the gas pressure in the main is substantially the same as the pressure provided to the customer.

(No Service Regulators)





§192.623 Low-Pressure Distribution Systems: *Maximum* and Minimum **Allowable Operating Pressure**

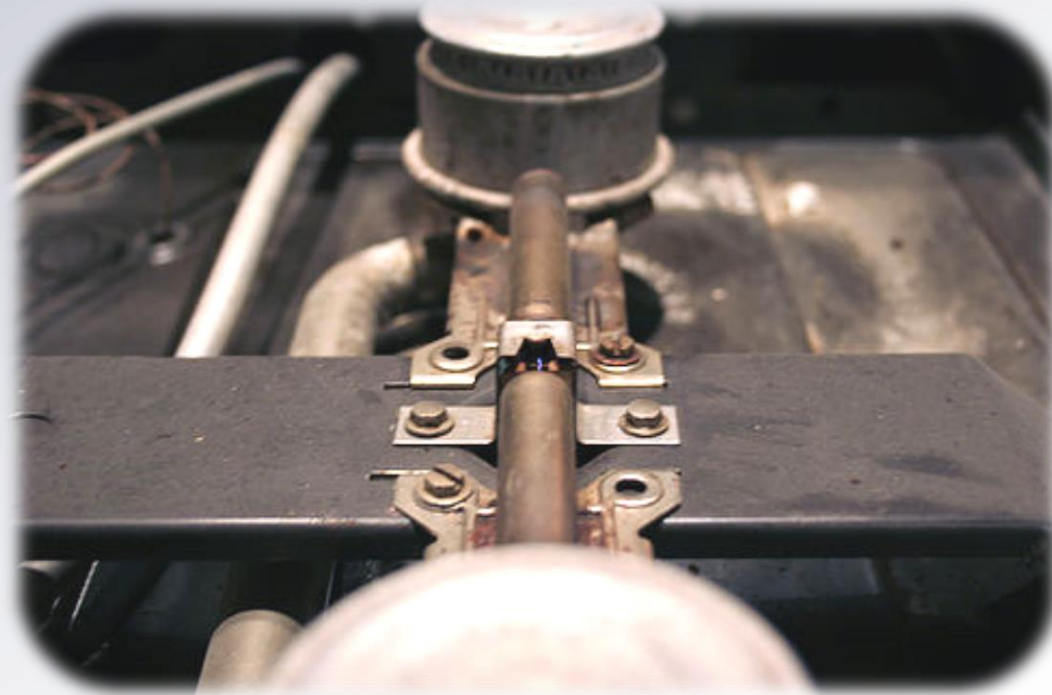


Pressure high enough to make unsafe the operation of properly adjusted low-pressure gas burning equipment.



§192.623 Low-Pressure Distribution Systems: Maximum and *Minimum* Allowable Operating Pressure

Pressure lower than the minimum pressure at which the safe and continuing operation of any properly adjusted low-pressure gas burning equipment can be assured.





PHMSA's goal is to improve the overall integrity of pipeline systems and reduce risks.